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COMPONENT PLACEMENT DEVICE AND METHOD

The invention relates to a component placement device which is provided with at least two component pick and place units which are connected to a movable frame, and at least two component feeding devices, which component placement device is suitable for simultaneously picking up by means of the component pick and place units components supplied by the component feeding devices.

The invention also relates to a method for picking up components by means of such a component placement device.

In a component placement device of the kind as disclosed in European patent application EP-A1-0092292, a number of component pick and place units can be moved collectively in X and Y directions between a number of adjacent component feeding devices and a substrate supported by a substrate support. The component pick and place units are located a certain pitch distance apart, which is equal to the distance between the adjacent component feeding devices.

In order to place components on the substrate, the frame is moved to above the component feeding devices after which components are simultaneously picked up from the component feeding devices by means of the adjacent component pick and place units. Since the components are picked up simultaneously, the time spent on picking up the components is relatively short for each component. After the components have been picked up by the component pick and place units, the frame is moved to above the substrate after which the components are simultaneously or sequentially placed on the appropriate positions on the substrate.

A drawback of the known component placement device is that the components need to be supplied relatively accurately by means of component feeding devices in order to ensure that the components can be picked up simultaneously by the component pick and place units.

There has been a tendency the past few years that the size of components has become ever smaller while the dimensions of components which are to be picked up by means of component pick and place units are in the order of 1 mm x 1/2 mm or less. If the components are not supplied accurately, the components cannot or not correctly be picked up simultaneously by means of the component pick and place units.

It is an object of the present invention to provide a component placement device that can be used to pick up components simultaneously and reliably.

This object is achieved by means of a component placement device according to the invention in that at least one component pick and place unit can be moved relative to the frame, while the mutual positions of the component pick and place units can be adjusted.

By displacing at least one component pick and place unit relative to the frame, the mutual positions of the component pick and place units can be set and adjusted to the expected or actual mutual positions of the components to be picked up, so that the components can be picked up simultaneously and accurately.

The mutual positions of the components to be picked up can be determined prior to the picking up or can be estimated statistically by means of components that have already been picked up by the component placement device and the deviations between the estimated positions of the components relative to the associated component pick and place units and the actual positions of the components relative to the corresponding component pick and place units can be defined using a camera for instance.

An embodiment of the component placement device according to the invention is characterized in that each component pick and place unit can be moved relative to the frame.

In this manner, each component pick and place unit can be moved individually relative to the frame, it for instance being possible for the frame to be used as a reference for all component pick and place units.

Another embodiment of the component placement device according to the invention is characterized in that a component pick and place unit can be moved relative to another component pick and place unit in a first direction, while the components which are to be supplied by means of the component feeding devices can be moved relative to one another in a second direction which extends transversely to the first direction.

By moving the pick and place units relative to one another in a first horizontal direction, for example, and moving the components relative to one another in a second horizontal direction, it is possible to displace the components and the pick and place units relative to each other in such a manner that components can be picked up simultaneously and accurately from the component feeding devices by means of the component pick and place units.

The invention also has for an object to provide a method for picking up components by means of a component placement device while the components can be picked up accurately and simultaneously from component feeding devices.

This object is achieved by the method according to the invention in that the components and the component pick and place units are set relative to each other prior to the simultaneous picking up of the components.

By setting the components and the component pick and place units relative to one another, it is possible to pick up the components correctly and accurately by means of component pick and place units.

An embodiment of the method according to the invention is characterized in that at least one component pick and place unit is moved relative to the frame, so that the mutual positions of the component pick and place units are set.

By moving at least one component pick and place unit relative to the frame, it is possible to set the mutual positions of the component pick and place units in such a manner that components can be picked up accurately and simultaneously by the component pick and place units from the component feeding devices.

Another embodiment of the method according to the invention is characterized in that the positions of the components to be picked up from the feeding devices are detected by a camera, after which the mutual positions of the component pick and place units are adjusted based on the mutual positions of the components to be picked up, after which the components are picked up by means of component pick and place units in a simultaneous and desired manner.

By detecting the positions of the components, which are to be picked up from the component feeding devices, by means of a camera, the desired mutual positions of the component pick and place units can be determined. Then, by moving the component pick and place units relative to the frame to the required positions, it is subsequently possible to accurately and simultaneously pick up components from the component feeding devices.

Another embodiment of the method according to the invention is characterized in that the positions of components picked up by the component pick and place units are determined relative to the component pick and place units, while deviations between the desired positions and the actually determined positions of the components are determined relative to the component pick and place units, after which, based on the deviations, the component pick and place units are moved relative to one another prior to the picking up of subsequent components.

By using information regarding the position of the components relative to the component pick and place units, which information is necessary for example to accurately place the components on a substrate, no additional measurements need to be carried out. Based on, for example, deviations between the desired position and the position actually found of a number of components picked up one by one by a component pick and place unit, it is possible for example to determine statistically the average deviation of a series of components fed by a specific component feeding device on the basis of which the associated component pick and place unit can be displaced relative to the frame prior to picking up of a subsequent component.

This method has the advantage that no time is required to measure the actual positions of the components by means of a camera. The advantage of detecting the positions of components to be picked up from the component feeding device by means of a camera is that it increases the accuracy with which the components can be picked up.

The invention will be further discussed with reference to the drawings in which:

Fig. 1 shows a top view of a first embodiment of a component placement device according to the invention.

Fig. 2 shows a top view of a part of the component placement device shown in Fig. 1.

Fig. 3 shows a top view of a part of a second embodiment of a component placement device according to the invention.

Fig. 4 shows a top view of another part of the second embodiment of a component placement device according to the invention.

Like parts in the figures are indicated by like reference numerals.

Fig. 1 shows a component placement device 1 according to the invention which is provided with a frame 2, which can be moved relative to a guide 3 in a direction equal to and opposite to the direction indicated by the arrow X. The guide 3 is rigidly connected with a slide 4, which can be moved in a direction equal to and opposite to arrow Y and which, with an end facing away from the frame 2, runs in bearings in a support 5. The component placement device 1 is further provided with a component feeding system 6 which comprises a plurality of component feeding devices 7 which are adjacent to each other. Each component feeding device 7 comprises a spool 8 on which a tape 9 is wound. The tape 9 has a number of chambers disposed in a row, one component being situated in each chamber. The chambers are covered with a removable foil. Such a component feeding device and such tapes are known per se and will therefore not be explained in further detail. Each component feeding device comprises a component pick up location 10 from where a component, transferred to this location by means of a component feeding device, can be picked up.

The component placement device 1 further comprises a substrate support 11 for supporting and transporting in the direction indicated by arrow X substrates 12 on which the components are to be placed.

The frame 2 is provided with a number of adjacent component pick and place units 13 which are each provided with a suction nozzle (not represented) which is used to pick up a component under vacuum. The suction nozzle can be displaced relative to the frame 2 in a direction Z that extends transversely to the plane of the drawing.

The component pick and place units 13 can be moved together with the frame 2 in a direction equal to and opposite to the arrow X and in a direction equal to and opposite to the arrow Y. Moreover, the component pick and place units 13 can be moved independently of each other relative to the frame 2 in a direction equal to and opposite to the direction indicated by the arrow X and in a direction equal to and opposite to the direction indicated by the arrow Y.

Fig. 2 shows part of a slide 2 of the component placement device 1 represented in Fig. 1.

The slide 2 comprises an elongated beam 21 which is provided with supports 22 which extend transversely to the beam. A component pick and place unit 13 is fitted to each support 22, which unit 13 is provided with an L-shaped guide 23 and a holder 24 supported by the L-shaped guide, in which holder 24 a pipette 25 is located which can be connected to a vacuum source (not represented). Each pipette 25 can be moved in a Z

direction which extends transversely to the plane of the drawing. The holders 24 can be moved individually relative to the associated L-shaped guide 23 by means of a respective actuator 26 in the directions indicated by the double arrow X1, X2, X3, X4, respectively. Each L-shaped guide 23 can be moved relative to the frame 2 by means of its own actuator 27 in the directions shown by the double arrow Y1, Y2, Y3, Y4 respectively. By means of the actuators 26, 27 which may comprise for example Lorenz actuators, threaded rod actuators, pinion rack actuators, piezo actuators and similar actuators, the pipette 25 of each component pick and place unit 13 can be set independently of the other pipettes 25 relative to the frame 2.

The operation of the component placement device 1 according to the invention is as follows. The frame 2 is driven in a Y and X direction until the pipettes 25 are located above the component pick up locations 10. By means of a camera, which is either permanently located above the component pick up locations 10 or connected to the frame 2, the positions of the components which are to be picked up are determined relative to the component pick up locations 10. Subsequently, deviations between the expected positions of the components relative to the pick up locations 10 and the actual positions relative to the pick up locations 10, detected by the camera, are detected by means of a processor. On the basis of the processor-detected deviations, the actuators 25, 26 of each component pick and place unit 13 are independently driven so that, after the pipettes 25 have been displaced to the desired positions relative to the frame 2, components can be picked up simultaneously from the locations 10 by means of the pipettes 25. Subsequently, the frame 2 together with all related component pick and place units 13 is moved to above a substrate 12 on which the components supported by the pipettes 13 are then placed either sequentially or simultaneously. The pipettes are moved in the Z direction relative to the frame 2, both when components are picked up or displaced by means of the pipettes 25.

Figs. 3 and 4 show top views of various parts of a second embodiment of a component placement device 31 according to the invention. The component placement device 31 includes a component feeding system 32 in which two component feeding devices 33 are located. These component feeding devices 33 are schematically represented by dashed lines. A component feeding system 32 with relatively closely spaced component feeding devices 33 is known in the industry under the name of Twin Tape Feeder (TTF) or multiple tape feeder with two or three component feeding devices 33. The component placement device 31 further includes a laser alignment module (LAM) 34 which can be used to determine the position and orientation of components 36 picked up by the pipettes 35. By

means of the laser alignment module 34, laser beams are aimed from a first side 37 in a direction indicated by the arrow X to a second side 38 of the laser alignment module 34, which laser beams are schematically represented by the reference numeral 39. As is clearly visible in Fig. 4, the component placement device 31 comprises two staggered pipettes 35 by means of which the components 36 can be picked up simultaneously. By rotating the pipette 35 in a φ direction which extends around the Z axis, while the components 36 supported by the pipettes 35 are located in the laser beams 39, the amplitude and location of the received laser beam is constantly changed on the side 38. Based on the laser beam received on the side 38 and the orientation of the pipette 35, it is possible to determine the position of the component 36 relative to the associated pipette 35. A laser alignment module of the kind is known per se and will therefore not be explained in detail. As soon as the orientation and position of the components 36 relative to the pipettes 35 is known, the pipettes 35 can be moved together in the X and Y directions to the location on the substrate on which the components 36 have to be placed. If the positions of the components 36 relative to the pipettes 35 deviate from the theoretically expected correct mutual alignments of the components 36 relative to the pipettes 35, the deviation is taken into account when the next pair of components 36 is picked up. For this purpose, the pipettes 35 can be moved relative to one another and opposite to the direction indicated by the arrow X because one pipette 35 is connected to a frame 41 by means of a guide 40, whereas the other pipette 35 is connected to a slide 43 by means of a guide 42, which slide 43 is connected to the frame 41 and can be moved by means of an actuator 44 in the direction equal to or opposite to the direction of the arrow X. The actuator 44 comprises a shaft 46, which is eccentrically connected with the frame 41, which shaft is located in a recess 47 of the slide 43. By rotating the shaft 46 in the direction equal to or opposite to the direction of the arrow P1, the slide 43 and the connected pipette 35 are moved in the X direction. By means of the guides 40, 42, the pipettes 35 can be moved independently in the direction equal to or opposite to the Z direction. For this purpose, the pipettes 35 are driven by the motors 48, 49.

The component feeding system 32 includes means for driving the corresponding component feeding devices in such a manner that the position of the component 36 to be picked up can be adjusted in the Y direction.

If, after two components 36 have been picked up, it is established by means of the laser alignment module 34 that there are deviations between the measured positions of the components 36 relative to the pipettes 35 and the theoretically expected and desired positions of the components 36 relative to the pipettes 35, which have a ΔX, ΔY of the one pipette 35

relative to the other pipette 35, the pipette 35 is moved by means of the actuator 44 over the desired distance in the X direction relative to the pipette 35 connected to the frame 41 when components 36 are again picked up by the pipettes 35. In addition, the component which is to be fed by means of one component feeding device 33 is shifted over a desired distance in the Y direction relative to the other component to be supplied. After components have again been picked up, the orientations and positions of the components 36 relative to the pipettes 35 are again established by the laser alignment module 34. In this manner, after a number of subsequent component pick ups, it is possible to determine a statistical value by which the components which are supplied by the different component feeding devices 33, show deviations relative to one another between the theoretically expected and desired positions and the actual positions. The advantage of thus measuring and correcting the positions in which the components are supplied and the pipettes 35 are positioned relative to one another, is that the speed at which the components can be picked up and placed on the substrate is relatively high, while the accuracy with which the components are picked up has considerably improved compared to the known component placement devices where components are picked up simultaneously.

It is alternatively possible to move only the component feeding devices in both X and Y direction relative to one another to achieve a correct simultaneous picking up by means of the component pick and place units.

It is also possible first to transfer the components by means of appropriate means to an intermediate position in which the components are suitably aligned to each other after which the components are picked up simultaneously.